Range-wide Status Assessment of *Howellia aquatilis* (water howellia)

Prepared for:

U.S. Fish and Wildlife Service

By:

Scott Mincemoyer

Montana Natural Heritage Program
Natural Resource Information System
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EXECUTIVE SUMMARY

Howellia aquatilis A. Gray (water howellia) is an annual, aquatic plant endemic to the Pacific Northwest region of the United States. Listed as a threatened species under the Endangered Species Act in 1994, its current known distribution includes the states of California, Idaho, Montana, Oregon and Washington. At the time of federal listing under the ESA it was known from 107 occurrences in three states. Today, 214 presumed extant occurrences are known, occupying approximately 285 acres. The majority of occurrences are concentrated in three metapopulations in the Swan Valley of west-central Montana, Spokane County, Washington and in western Washington, mainly on Fort Lewis Military Reservation.

The federal government manages lands partially or entirely encompassing 82% of extant occurrences, with one agency, the U.S. Forest Service, managing 57% of known occurrences. The U.S. Fish and Wildlife Service manages lands with 35 occurrences and the U.S. Department of Defense has 17 occurrences. In Montana, "checkerboard" land ownership in the Swan Valley complicates management with many occurrences occupying more than one ownership.

Primary threats to water howellia are from changing water levels and invasive species. Consecutive years of drought or exceedingly wet years may negatively affect populations if ponds remain dry or if they do not dry out enough to allow germination in the fall. Monitoring data has shown that populations have the ability to rebound following consecutive years of unfavorable conditions, though seed viability and germination rates are significantly reduced.

Invasive species pose a serious and long-term threat to water howellia. Introduced genotypes of *Phalaris arundinacea* (reed canary grass) and *Iris pseudacorus* (yellow flag iris) are two of the largest threats to date. *P. arundinacea* is a potential threat to water howellia range-wide. In contrast, *I. pseudacorus* has been a problem in water howellia ponds mainly in western Washington. Additional aquatic and riparian invasive species also pose threats on a more limited scale, though several have the potential to more severely impact water howellia in the future.

Monitoring programs have been implemented on the Flathead National Forest, Montana, Fort Lewis, Washington and for the Idaho population, with several years of data now available for these populations. Additional monitoring programs still need to be implemented for other populations.

Total population numbers for *Howellia aquatilis*, as with any annual species, are difficult to estimate without quantitative survey data over many years. Approximately ¼ of the known populations have only been visited once, and in many cases only presence/absence data is available due to the difficulty of collecting accurate and precise quantitative data for the aquatic species. If the sum of the minimum and maximum number of plants estimated at each occurrence are used as a basis for the species total population, a range of 18,000-138,000 plants is derived. A sum of the median population size for each occurrence results in a figure of approximately 51,000 plants.

The annual nature of the species in conjunction with its narrow ecological niche makes it vulnerable to long-term unfavorable weather patterns and climate change. In addition, the clustering of populations in just a few geographic areas also makes it more susceptible to regional and local influences. Invasion of the species' habitat by non-native species is also a problem that most likely will continually need to be addressed. However, the majority of known populations occur on public lands providing the opportunity for the implementation of conservation measures and strategies beneficial to the long-term survival of the species. With implementation of management plans, continued monitoring and conservation protection of additional populations, delisting should be an achievable goal.

ACKNOWLEDGEMENTS

This assessment was made possible by a grant from the U.S. Fish and Wildlife Service. Numerous individuals and organizations provided monitoring and occurrence data, including but not limited to the California Natural Diversity Database, Idaho Conservation Data Center, Oregon Natural Heritage Program, Washington Natural Heritage Program, Flathead National Forest and the Land Condition Trend Analysis Program at Fort Lewis Military Reservation. Thanks to Henning Stabins for providing management information for Plum Creek Timber Company land in relation to water howellia and to Karen Gray for providing additional information on the Idaho population. Thanks to Kathy Lloyd and Kathy Martin for diligently updating the Montana Natural Heritage Program's database of Montana water howellia occurrences. Finally, thanks to several reviewers who provided valuable input and comments.

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I. INTRODUCTION

Howellia aquatilis A. Gray (water howellia) is an annual, aquatic plant endemic to the Pacific Northwest region of the United States. Listed as a threatened species under the Endangered Species Act in 1994, its current known distribution includes the states of California, Idaho, Montana, Oregon and Washington. Its biology and ecology make it vulnerable to short and long-term changes in climate and weather patterns as well as anthropogenic threats.

Thorough status reviews for the species are out of date with the most recent ones being completed by Roe and Shelly (1992) and the U.S. Fish and Wildlife Service (1994). In addition, a draft recovery plan was prepared for the species in 1996 but never finalized and adopted by the U.S. Fish and Service (USFWS 1996). In 1994, a conservation strategy for the species was finalized by Region 1 of the U.S. Forest Service covering all national forest lands in Montana.

The purpose of this assessment is to compile and analyze current data on the known distribution, population ecology and management status of *Howellia aquatilis*. In particular, population trends and current threats to the species are of particular importance in determining its current range-wide status and whether a change in listing status may be warranted.

II. SPECIES INFORMATION

A. Classification

1. Scientific Name: *Howellia aquatilis* A. Gray

2. Common Name: water howellia

3. Family: Campanulaceae (harebell family)

4. Type Description and Specimens Cited: Gray, Asa. 1879. Proceedings of the American Academy of Arts and Sciences. 15:43-44.

Thomas & Joseph Howell 137, 1879. Oregon, Sauvies Island (Holotype: GH). Probable Isotypes at NY.

Herbarium reference codes are from Holmgren and Holmgren (1990).

5. Size of Genus: Howellia is a monotypic genus.

B. Present Legal or Other Formal Status

1. Global

i. Legal Status: None.
ii. Heritage Rank: G3. (See Appendix D for Heritage Rank Definitions.)

2. National

a. Legal Status: Water howellia is endemic to the United States. The species was listed as threatened under the Endangered Species Act on July 14, 1994 (U.S. Fish and Wildlife Service 1994).

3. State

a. California

i. Legal Status: None.
ii. Heritage Rank: S1.

b. Idaho

i. Legal Status: None.
ii. Heritage Rank: S1.

c. Montana

i. Legal Status: None.
ii. Heritage Rank: S2.

d. Oregon

i. Legal Status: None.
ii. Heritage Rank: S1.

e. Washington

i. Legal Status: None.
ii. Heritage Rank: S2S3.

C. Description

1. General Non-technical Description: Water howellia is a glabrous, much-branched, annual, aquatic herb with fragile, submerged and floating stems that are up to 100 cm tall. The simple, alternate or occasionally opposite or whorled stem leaves are narrowly linear, 1-5 cm long, and entire-margined. Beneath the surface of the water, small flowers that produce seeds without opening are solitary in the leaf axils. Once the stems reach the surface, small, white flowers are borne in a narrow, terminal, leafy-bracted inflorescence. The white corolla is 2-3 mm long. Flowering occurs on the surface of the water. The fruit, which forms below the attachment of the petals, is a capsule that is 1-2 cm long containing elongate seeds that are up to 2-4 mm long.

2. Technical Description: Flaccid annual, aquatic herb, mostly submergent, often with emergent branches; plants naked below, branched above; whole plant glabrous, green, about 10-60 cm. tall, occasionally taller; leaves numerous, alternate, or some of them subopposite or whorled in threes, linear or linear-filiform, entire or nearly so, 1-5 cm. long, up to 1.5 mm wide; flowers white, mostly 3-10, axillary, often scattered,

pedicellate or subsessile, both petaliferous (when emergent), the fully-developed corollas about 2-2.7 mm long, irregular, with the tubes deeply cleft dorsally, and five-lobed; filaments and anthers connate, two of the anthers shorter than the others; calyx lobes 1.5-7 mm. long; stout pedicels 1-4 (8) mm. long, merging gradually with the base of the capsule; ovary unilocular, with parietal placentation; stigma 2-lobed; fruit 5-13 mm. long, 1-2 mm. thick, irregularly dehiscent by the rupture of the very thin lateral walls; seeds large, 2-4 mm. long, 5 or fewer, shiny brown (Shelly 1988).


Figure 1. *Howellia aquatilis* plants


Figure 2. *Howellia aquatilis* flowers

3. Similar Species: *Callitriche heterophylla* (Callitrichaceae) is vegetatively similar to water howellia and found growing with it. However, the submergent linear leaves of the latter species are most often opposite and only rarely whorled. The floating leaves are broadly ovate in contrast to the linear leaves of water howellia. Additionally, the flowers are axillary and inconspicuous due to the lack of a corolla.

In California, *Legenere limosa* (Campanulaceae) occurs in similar habitats as water howellia and in the same geographic area. However, the branching pattern of *L. limosa* is different and the leaves are shorter and not as linear. In Montana, *Downingia laeta*, also in the Campanulaceae, occurs in shallow water and drying mud around ponds and lakes in the valleys and on the plains, though it is easily distinguished by its light blue to purplish flowers marked with white or yellow.

D. Population Biology and Ecology

1. Reproductive Biology and Phenology: *Howellia aquatilis* is an annual, reproducing entirely by seed. The plant is predominantly a winter annual with germination taking place in the fall and seedlings over-wintering and resuming growth in the spring. Germination of seeds occurs only when ponds dry out and seeds are exposed to air (Lesica 1990, 1992). Thus, the population size in a given year is affected by the extent to which the pond dries out at the end of the previous year. Due in part to this dependence, population size varies widely from year to year. Exceedingly wet years will detrimentally affect population size the next year since seeds will not germinate. Conversely, very dry years may also adversely impact populations if enough water is not present to support a “good” population and subsequent production of seed. Long-term seed viability is uncertain though it has been shown that seeds lying in the soil longer than eight months have decreased rates of germination and vigor (Lesica 1992). Thus, two or more consecutive years of exceedingly wet conditions or dry conditions may have a severe detrimental impact on population size due to the decreased number of viable seeds. Monitoring data from Montana populations have shown populations rebound after two consecutive years with no plants observed. This provides some evidence that a significant number of seeds remain viable for at least three years, providing a buffer against unfavorable growing conditions in consecutive years.

Water howellia produces both submerged, cleistogamous flowers (flowers that do not open and are self-pollinated) and emergent, chasmogamous flowers (flowers that open and allow for pollination). Studies by Lesica et al. (1988) and Shelly and Moseley (1988) report that

self-pollination appears to be the common means of fertilization and that out-crossing, though possible, is probably extremely rare.

Plants begin growth in the spring. In low elevation populations in western Washington, this is typically early April and in western Washington and Montana by early May. Emergent flowers bloom soon after the stems reach the water surface and are present from June into August. Seed dispersal starts in June from submerged flowers and extends until late summer from emergent flowers (USFWS 1996). Spread of seeds by waterfowl or other animals between ponds, though possible, has not been documented.

2. Genetics: Original isozyme studies by Lesica et al. (1988) showed a very low level of genetic diversity within and among populations. Additional isozyme work by Brunsfeld and Baldwin (1998) included California populations, used the same 18 loci as Lesica (1988), and five additional loci, and also did not detect any variation within or among populations. However, limited chloroplast DNA sequence data and Random Amplified Polymorphic DNA (RAPD) analyses do show some variation among populations. The interpretation and expectations for genetic variation for *Howellia aquatilis* as summarized by Brunsfeld and Baldwin (1998) are, "The short generation time of the species should foster a rapid generation of genetic diversity and rate of evolution. On the other hand populations are known to fluctuate in size leading to periodic bottlenecks and genetic drift in unfavorable years."

E. Geographic Distribution

1. Range: *Howellia aquatilis* is a Pacific Northwest endemic known from northern California, western Oregon, Washington, northern Idaho and western Montana. The first collection of the species was from western Oregon (Multnomah County), in a slough on Sauvies Island along the Columbia River near Portland in 1879. Subsequent collections were made in Multnomah County in 1881, 1885 and 1886, Clackamas County in 1892 and Marion County in 1926. A California population was discovered in Mendocino County in 1928, an Idaho population in 1967, Montana in 1978 and Washington in 1937 (USFWS 1994, USFWS 1996, Shelly and Moseley 1998). At the time of listing under the Endangered Species Act, 107 total extant occurrences were known. These were found in Montana (59), Washington (47) and a single occurrence in Idaho (USFWS 1994). Populations in California and Oregon were believed to be extirpated. Today, there are 214 total occurrences known from five states: California (6), Idaho (1), Montana (138), Oregon (1) and Washington (68). The majority of the occurrences are in three metapopulations, one in the Swan Valley in western Montana, one in Spokane County in eastern Washington and the third in Pierce County in western Washington.

California:
In 1928, Alice Eastwood collected the plant near Howard Lake in Mendocino County. Surveys in 1979 and 1980 failed to relocate the plant. However, the plant was again documented in the area in 1996 and it is currently known from six sites in Mendocino County (USFWS 1994, Isle 1997, California Natural Diversity Database 2005).

Idaho:
The first collection of water howellia from the state was reported in Kootenai County in 1892 near Spirit Lake. It is believed that the location information with this specimen is in error and surveys in the area have failed to locate any populations (Shelly 1988). One population, occupying 3 ponds, in Latah County was discovered in 1967 and has been monitored annually from 1999 to 2004 (Idaho Conservation Data Center 2005, Gray 2005). Extensive surveys during 1994 and several other years have failed to locate any additional occurrences (USFWS 1996).

Montana:
Bruce McCune made the first known collection of the species in the state in the Swan River Valley (Missoula County) in 1978 (McCune 1982). By 1986, only 13 total populations were documented. One year later an additional 39 occurrences were located in the general vicinity. This number remained fairly stable for seven years with only six additional populations discovered. In 1995 an additional 43 ponds were found to contain populations, bringing the total known occurrences to 101 in the state. Since 1995, populations have

been discovered in an additional 37 ponds bringing the total number of documented occurrences to 138 in the Swan Valley. However, 45 of the populations have not been visited for more than five years and 27 occurrences have only been visited once (Montana Natural Heritage Program Database 2005).

Oregon:
As noted above, the first known collection of the species occurred in 1879 from Sauvies Island, Multnomah County. A subsequent collection from the Island was made in 1886. However, it has not been seen since then. Other historical collections occurred in 1892 in Clackamas County and in 1926 in Marion County. It was long presumed that water howellia was extirpated in the state until a rediscovery of the species in 2002 on the William Finley National Wildlife Refuge in Benton County in the west-central part of the state (USFWS 1996, USFWS 1994, Oregon Natural Heritage Program Database 2005).

Washington:
In 1937, two collections of water howellia were made on the west side of the Cascades, one in Thurston County and the other in Mason County (USFWS 1996). No other collections were made until 1978, when a population was discovered in eastern Washington near Spokane. An additional population was discovered in 1980 in Clark County across the Columbia River from the type locality. Many additional populations have been found since the 1980's in Spokane County and on McChord Air Force Base and Fort Lewis Military Reservation in Pierce County, bringing the total number of presumed extant occurrences in the state to 68, including one new population discovered on Fort Lewis in 2004. Twenty-five of the Washington populations have not been visited for more than 10 years and 28 occurrences have only been visited once (USFWS 1996, Washington Natural Heritage Program Database 2005, Wolford 2004).

Table 1. Date of last observation of presumed extant occurrences of *H. aquatilis* by state and ownership.

State	**Ownership**	**Pop. Totals by Ownership**	**Date of Last Observation (# of Populations)**			
			2000-2004	**1995-1999**	**1990-1994**	**pre-1990**
California	USFS	6	2	4		
Idaho	Private*	1	1			
Montana	Plum Creek Timber Company	12	1	11		
	Plum Creek/State	1	1			
	Plum Creek/Private	1		1		
	Private (Other)	3		2	1	
	State	2	2			
	TNC	1		1		
	USFS	82	77	5		
	USFS/Plum Creek	19	10	9		
	USFS/State	1	1			
	USFS/Other Private	16	1	12		3
Oregon	USFWS	1	1			
Washington	BLM	1			1	
	Private	13		2	1	10
	State	3	1	2		
	USDOD	17	17			
	USFWS	34		21	13	
Totals:		**214**	**115**	**70**	**16**	**13**

*Property willed to the National Audubon Society (Idaho Conservation Data Center Database 2005)

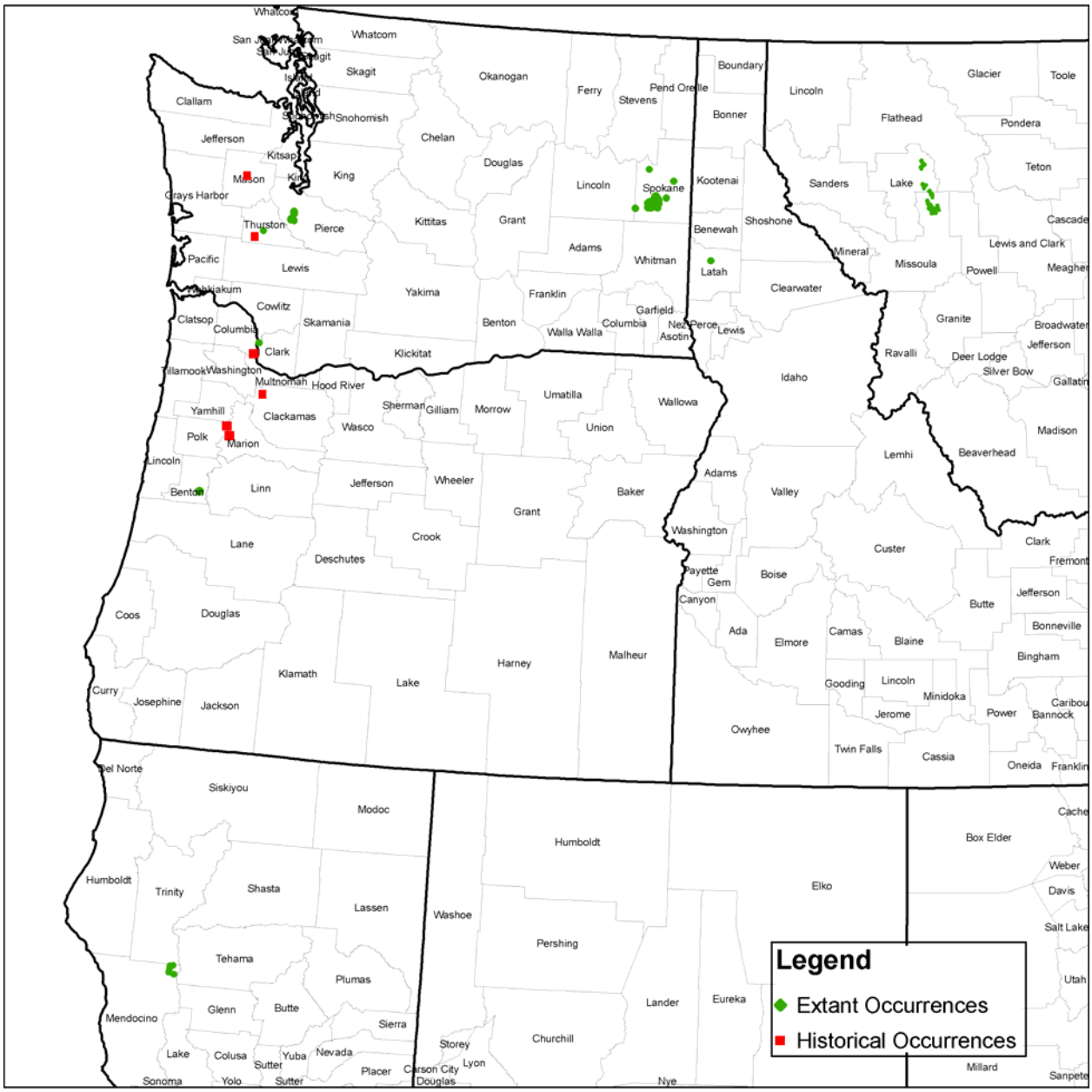

Figure 3. Distribution of *Howellia aquatilis* (Extant and Historical Occurrences)

2. Historical Populations:

Idaho:
Sandberg, J.H. 669. July 22, 1892. Reported from Kootenai County. Vicinity of Spirit Lake. Floating in subalpine lake.

It is believed that the location information associated with this collection may be in error. Attempts to relocate populations in the area in 1988 failed to find any populations (USFWS 1996, Shelly and Moseley 1988).

Oregon:
Multnomah County, Sauvies Island (type locality). 1879. Last seen in 1886. However, a new population was discovered across the Columbia River in Clark County, Washington in 1980.

- *Thomas & Joseph Howell 137*

Clackamas County, Lake Oswego. 1892. Not seen since original collection.
- *Howell s.n.*

Marion County, near Painter's Woods and Salem. 1926. Last seen in 1935.
- *Thompson 4927, 4967*
- *J.C. Nelson 5075*
- *M.E. Peck 15935*

Marion County, Mission Bottom, near Salem. 1977.
- Reported by W. Bluhm

The Marion and Clackamas County sites are in areas that have largely been developed (Shelly and Moseley 1988).

Washington:
Mason County, small lake about 20 miles north of Shelton. 1937. Last seen in 1937.
- *W.J. Eyerdam 1211*

Thurston County, roadside pond in or near Millersylvania State Park. 1937. Last seen in 1937 (USFWS 1996).
- *J. Rudd s.n.*

3. Additional Survey Areas:

Idaho:
Extensive searches in northern Idaho in June 1988 did not result in the discovery of any new populations (Shelly and Moseley 1988).

Montana:
437 ponds searched in Montana between 1987 and 1991 in Flathead, Lake and Missoula Counties (Roe and Shelly 1992, Schassberger and Shelly 1991, Shelly 1989).

Oregon:
Intensive surveys failed to relocate any occurrences near the historical collections (USFWS 1996).

4. Extant Sites: *Howellia aquatilis* occurrence data is provided in Appendices A and B.

F. Habitats

The dominant habitat for *Howellia aquatilis* is small, vernal, freshwater wetlands and ponds with an annual cycle of filling with water and drying up late in the season (Figures 4-7). These vernal ponds and wetlands usually fill with water over the fall, winter and early spring, but then at least partially dry up towards the end of the growing season. Depending on annual patterns of temperature and precipitation the drying of the pond may be complete or partial by the fall. These sites are usually shallow and less than one meter in depth, although water howellia is sometimes found in water up to two meters deep (USFWS 1996). Additionally, a few occurrences of water howellia are found in oxbow sloughs and surrounding marshy areas such as those on the Swan River Oxbow Preserve managed by The Nature Conservancy in Montana and the type locality in Oregon. Across its range, *Howellia aquatilis* occurs at elevations as low as three meters in Washington to 1372 meters in Montana.

Howellia aquatilis ponds are typically surrounded at least in part by forested vegetation. Tree species vary across the range of water howellia, though usually include some broadleaf deciduous trees. In Montana, *Populus trichocarpa* (black cottonwood) is commonly associated and to a lesser extent, *Populus tremuloides* (quaking aspen) and *Betula papyrifera* (paper birch). In eastern Washington, *Populus tremuloides* is an associate and *Fraxinus latifolia* (Oregon ash) is commonly associated with the populations in the western part of the state.

A variety of deciduous shrubs and herbaceous species are commonly associated with water howellia occurrences, two of the most common being *Carex vesicaria* (inflated sedge) and *Phalaris arundinacea* (reed canary grass). The latter species being probably of mainly introduced origin. Table 2 lists species commonly associated with water howellia occurrences by state.

Figures 4-7. *Howellia aquatilis* habitats.

Figure 4. Condon Creek, Montana water howellia pond (unknown EO #)

Figure 5. Lindbergh Lake, Montana water howellia pond (EO #2)

Figure 6. Spokane County, Washington water howellia pond

Figure 7. Lindbergh Lake, Montana water howellia pond (EO #44)

Bottom surfaces of the ponds and wetlands usually consist of organic sediments underlain by consolidated clay (USFWS 1996). In Montana, soil units in the Swan Valley are comprised of Cryochepts, Eutroboralfs and Eutrochrepts from parent materials of clayey alluvium and clayey colluvium (Shelly and Moseley 1988). Soils on the 87,000 acre Fort Lewis Military Reservation are generally composed of nutrient poor, well-drained glacial till (Clegg and Lombardi 2000).

Analysis of water chemistry by Lesica (1992), Shapley (1998) and Reeves (2001) in the Swan Valley of Montana shows specific conductance readings from <30 µS/cm to 400 µS/cm with most ponds below 150 µS/cm. Measurements of pH ranged from 6.2 to 7.8 with most measurements between 6.5 and 7.5. The general conclusion drawn from these data is that water howellia prefers freshwater ponds close to neutral.

Prior to Shapley's analysis of the basin morphology of water howellia ponds in the Swan Valley, most ponds were considered to be closed under present climatic conditions (Shapley and Lesica 1997). However, 12 of 34 ponds studied were observed to have spill points occupied frequently enough to maintain some channel morphology and that interpond exchange of surface water during wet periods appeared to be more common than previously supposed.

Table 2. Vascular plant species commonly associated with *Howellia aquatilis* sites by state. This is not meant to be an exhaustive list of all vascular species recorded at *Howellia aquatilis* sites. Data is derived from Heritage Program element occurrence records, Gilbert (2002), Gilbert and Lombardi (1999) and Shelly and Moseley (1988).

Species	**CA**	**ID**	**MT**	**OR**	**WA**
Abies grandis		X	X		
Abies lasiocarpa			X		
Acer macrophyllum					X
Acorus calamus		X			
Alisma plantago-aquatica		X	X		X
Alnus incana		X	X		
Alopecurus aequalis		X	X		X
Amelanchier alnifolia		X			
Callitriche heterophylla		X	X		X
Callitriche stagnalis					X
Carex obnupta					X
Carex serratodens	X				
Carex spp.	X				
Carex vesicaria		X	X		X
Cicuta douglasii		X			
Cornus stolonifera		X	X		X
Crataegus douglasii		X			
**Dactylis glomerata*		X			
Eleocharis palustris		X	X	X	X
Epilobium oregonense	X				
Equisetum fluviatile			X		X
Fraxinus latifolia					X
Glyceria borealis	X		X		
Glyceria elata	X	X			
Glyceria grandis		X			
Glyceria occidentalis		X			X
**Iris pseudacorus*					X
Juniperus communis			X		
Larix occidentalis			X		
Lemna minor		X			X
Lemna spp.	X				
Lonicera involucrata					X
Ludwigia palustris				X	X
Mentha arvensis		X			X
Myosotis laxa	X				X
**Myosotis scorpioides*		X			X
Nuphar polysepalum					X
Oenanthe sarmentosa					X
**Phalaris arundinacea*		X	X		X
Philadelphus lewisii					X
Physocarpus capitatus		X			
Picea engelmannii		X	X		
Pinus contorta		X	X		
Pinus ponderosa		X	X		X

Species	CA	ID	MT	OR	WA
Polygonum coccinium					X
Populus tremuloides			X		X
Populus trichocarpa			X		X
Potamogeton gramineus			X		
Potamogeton natans				X	X
Potamogeton nodosus	X				
Potamogeton pusillus	X				
**Prunus avium*					X
Pseudotsuga menziesii		X	X		
Pyrus fusca					X
Ranunculus aquatilis	X		X	X	X
Ranunculus flabellaris		X			X
Ranunculus flammula	X				X
Rhamnus alnifolia			X		
Salix bebbiana		X			
Salix drummondiana		X			
Salix lasiandra					X
Salix spp.			X		X
Sium suave		X	X		X
**Solanum dulcamara*		X			X
Sparganium emersum		X		X	X
Sparganium minimum			X		
Sparganium spp.	X				
Spiraea douglasii					X
Symphoricarpos albus		X			X
Typha spp.	X				
Utricularia vulgaris	X	X			X
Veronica anagallis-aquatica					X
Veronica scutellata		X			X

*non-native species

G. Land Ownership

The federal government manages lands that completely or partially encompass 82% of known *Howellia aquatilis* sites (see Table 1). One agency alone, the U.S. Forest Service (USFS), manages lands that encompass 57% or 124 of the total populations. In addition, the U.S. Fish and Wildlife Service (USFWS) manages lands where another 35 populations occur. All of the USFWS occurrences, except the Oregon population, occur in Washington. Also in Washington, 17 populations occupy lands owned by the U.S. Department of Defense (McChord Air Force Base and Fort Lewis). State agencies in Montana and Washington manage lands with another seven populations.

The remaining 15% of populations occur on a variety of privately owned lands. However, one population occurs on a Nature Conservancy Preserve in Montana, the Idaho population occurs on property willed to the Audubon Society (IDCDC database 2005) and 33 occurrences in Montana occur partially or entirely on Plum Creek Timber Company lands.

In Montana, 41 populations cross ownership boundaries with many of these occupying both Flathead National Forest lands, Plum Creek Timber Company lands or other privately owned lands. Land ownership in the Swan Valley, where all the Montana populations occur, is

largely in a "checkerboard pattern" of National Forest, state lands, Plum Creek Timber Company and other private lands, resulting in part from the Railroad Land Grants in the late 1800s.

H. Potential Threats to Known Populations

1. Human Land Use: A variety of land uses still pose potential threats to *Howellia aquatilis* across its range, including activities related to timber harvesting, land development, recreation, military activities, and grazing. A total of 67 occurrences in Montana and Washington occur partially or wholly on private lands that afford little or no protection from human impacts. Development of some of these private lands in the Swan Valley of Montana and Spokane County, Washington is still a possibility that could adversely affect not only populations on those lands but also populations on adjacent public lands.

On Fort Lewis Military Reservation, signs have been erected around all water howellia ponds noting the presence of a federally threatened wetland plant. Also, military operations do not generally occur in wetland habitats so direct impact to water howellia populations from military activities is not currently a problem. However, trampling of the drawdown zone, particularly in the Dailman wetland population, has been observed and is believed to be caused primarily by duck hunters (Gilbert and Lombardi 1999, Clegg and Lombardi 2000).

In the past, timber harvesting and related activities have been documented in and adjacent to water howellia ponds in the Swan Valley, including removal of overstory trees, road building and even deposition of logging slash in the water (Shelly 1988, Shelly and Moseley 1988, USFWS 1994). Timber harvesting impacts on *Howellia aquatilis* on USFS lands in the Swan Valley have been minimized with adoption of 300 foot protective buffers around occupied ponds as recommended in the Conservation Strategy (USDA Forest Service 1994, 1997). Measures to exclude cattle from ponds have also been implemented on the Flathead National Forest.

Plum Creek Timber Company has implemented a water howellia management plan on its lands that provides protection to this species. The plan calls for following all Montana Streamside Management Zone (SMZ) laws and Best Management Practices. For occurrences that aren't regulated under the SMZ law, Plum Creek calls for implementation of a no equipment zone or that activity should take place when the ground is frozen to minimize soil impacts and sedimentation. The plan also calls for protection of water howellia sites by incursion from cattle.

2. Natural Disturbances: Invasion of occupied water howellia sites by non-native species, particularly *Phalaris arundinacea,* has been a concern since the 1980's. Most of the *P. arundinacea* occurring in water howellia ponds is presumed to be of non-native origin. *P. arundinacea* occurs in many wetland and riparian sites in Idaho, Montana and Washington and has been documented in almost all Washington occurrences, the Idaho location and many Montana water howellia occurrences. In Montana, 20 of 68 ponds monitored by the Flathead National Forest are known to contain *P. arundinacea* (Davis 2004). Monitoring of water howellia ponds on the Flathead National Forest does show a slight increase in the frequency of *P. arundinacea* in the ponds from the initial monitoring year of 1998 but it has remained relatively stable the following five years (Davis 2004). Conversely, monitoring on the Swan River Oxbow Preserve in Montana by Lesica (1997) in the *Phalaris*-marsh ecotone shows an increase in *P. arundinacea* cover and a corresponding drop in *H. aquatilis* cover over a nine-year period. Though studies such as Lesica's do show that water howellia is negatively influenced in the immediate area of dense *P. arundinacea* stands, it is not known to what extent *P. arundinacea* will invade and form dense stands in water howellia ponds in Montana.

In Idaho, *P. arundinacea* has demonstrated the ability to completely invade and form dense stands in water howellia ponds. Clipping and

excavating *P. arundinacea* in the Idaho ponds is on-going and water howellia was observed in 2004 in areas where *P. arundinacea* was removed. Additional species that are invading and competing with water howellia in Idaho include *Solanum dulcamara* and *Acorus calamus* (Gray 2005).

Janice Hill, June 28, 2004

Figure 8. Idaho howellia pond dominated by *Phalaris arundinacea* (taller, lighter colored grass along outer edges) and *Acorus calamus* (darker, shorter species in middle of pond).

Iris pseudacorus (yellow flag iris), another non-native species, has been invading water howellia wetlands on Fort Lewis and appears to be spreading rapidly in Shaver Kettle and the Chambers Lake complex. In 2003, an eradication program was initiated by hand pulling the species in the majority of the Chambers Lake complex. Results of this effort are not yet available (Gilbert 2001, Wolford 2003). The possible introduction of a *Myriophyllum* spp. (water milfoil) in the Dailman wetland has also been noted and is a cause for concern (Clegg and Lombardi 2000).

Lythrum salicaria (purple loosestrife) is another non-native wetland species that may yet pose problems in water howellia ponds. Quick response and eradication measures should be taken with these latter two species and any other new invasives at all water howellia sites.

Long-term weather patterns also have a direct and potentially negative impact on water howellia. Consecutive years of drought or exceedingly wet years pose problems for water howellia as previously mentioned. Monitoring data have shown that seeds apparently remain viable for up to three years, though viability is probably substantially reduced (Lesica 1992). The potential for a severe reduction or eradication of the species in a geographic area does exist during several years of consecutive drought. On Fort Lewis, unsuitable water levels are identified as one of two primary threats to water howellia populations, the other being wetland plant succession (Wolford 2003).

III. Assessment and Recommendations

A. General Assessment of Trends and Status

Total population numbers for *Howellia aquatilis*, as with any annual species, are difficult to estimate without quantitative survey data over many years. There is a general lack of quantitative survey data for the majority of water howellia occurrences. Approximately ¼ of the known populations have only been visited once and even if the population size was estimated during that site visit, abundance varies dramatically from year to year depending on climate and other factors. Accurate and precise measures or estimates of abundance are difficult to collect due to the aquatic nature of the plant. This annual variation and difficulty in collecting accurate survey data means that it takes many years of data across the range of the species to adequately estimate population size. If the sum of the minimum and maximum number of plants estimated at each occurrence are used as a basis for the species total population, a range of 18,000-138,000 plants is derived. A sum of the median population size for each occurrence results in a figure of approximately 51,000 plants. Range-wide population estimates derived from quantitative sampling data are available by year in Figure 8.

Since abundance varies widely year to year, a single estimate does not provide very meaningful data about a particular population. In fact, over 50 occurrences have only been surveyed once and another 45 locations have

only been surveyed twice (Figure 9). One or two visits to an individual population do not provide enough sample points to make an assessment of that population's general size and importance to the overall viability of the species.

Another important aspect to consider is the number of individual occurrences. The number of known populations or occurrences, though not necessarily a good predictor of a species' viability or trend, at least provides documentation about the species over time. Over the past two decades, the number of documented occurrences has more than doubled from 72 in 1988 to 214 in 2004 (Table 3). In the past four years alone, approximately two-dozen new occurrences have been documented. It is not unrealistic to expect that just as many new occurrences may be documented in the next four to five years if intensive surveys are conducted and weather conditions are favorable to the species' biology.

Table 3. Number of known *Howellia aquatilis* occurrences by year.

Year	# of Occurrences	Source
1988	72	Shelly and Moseley 1988
1990	76	Schassberger and Shelly 1990
1992	76	Roe and Shelly 1992
1993	79*	USFWS 1993
1994	107**	USFWS 1994
1996	160	USFWS 1996
1997	170	USFS 1997
1998	180	Forum on research and management of *Howellia aquatilis* 1998
2000	199	Natural Heritage Program data
2004	214	Natural Heritage Program data

* Number of known occurrences at time of proposed federal listing under the Endangered Species Act.
** Number of known occurrences at time of federal listing under the Endangered Species Act.

Figure 9 provides data on the number of occurrences sampled each year and the associated estimate of population size for that year. Additionally, the number of new occurrences "discovered" each year is provided. Wide fluctuations in population estimates among years are directly tied to the number of populations sampled, suitable growing conditions that year and suitable germination conditions the previous year. Also directly influencing estimates of population size for any given year is whether or not a sampled population was given a quantitative measure of abundance or just the presence (or a qualitative abundance) of water howellia was noted.

The occupied habitat of water howellia was estimated at less than 200 acres at the time of listing (USFWS 1994). A current analysis of the area mapped using Natural Heritage Program data estimates a total occupied area of 285 acres. This estimate is derived by using the actual area mapped for all Montana occurrences plus figures provided by the four other states in which the species occurs. Occurrences that do not have an estimated or mapped area were given a figure of 0.1 acre. The majority of occupied habitat occurs in two metapopulations: 119 acres in the Swan Valley of Montana and 129 acres on Fort Lewis in Pierce County, Washington. The actual occupied habitat might be higher if more accurate data were available for California and numerous Washington populations. However, the area occupied by the species in any given year is probably far less than the 285 acres estimated as occupied habitat.

It is unknown how widespread the species was before European settlement and modern development in the Pacific Northwest. Including historical collections of the species does not significantly increase the range of the species. Though previous reports have presented the idea that the species was more widespread across the region, there are no "concrete" data to support this claim and the area occupied by the species was probably small even before European settlement of the Pacific Northwest due to the narrow habitat requirements of the species. Since it was proposed for listing under the ESA in 1993, rediscoveries of the species in California, Oregon and Pierce County, Washington have extended the currently known range to generally cover known historical collection locations (USFWS 1993).

Transplant studies of water howellia into unoccupied though apparently suitable habitat occurred in the Swan Valley, Montana in 1989. Fifteen soil plugs taken from a dense water howellia population were deposited into four unoccupied ponds. Two of these ponds contained water at the time of the transplant and it is presumed never dried out. Subsequent monitoring of these ponds the following two years did not detect any water howellia. The other two ponds did support small populations in 1990 and 1991 (Schassberger and Shelly 1991, Roe and Shelly 1992). Pond A (MT EO# 130) was also observed to have two plants in 1992 and monitoring in 2001 documented four plants.

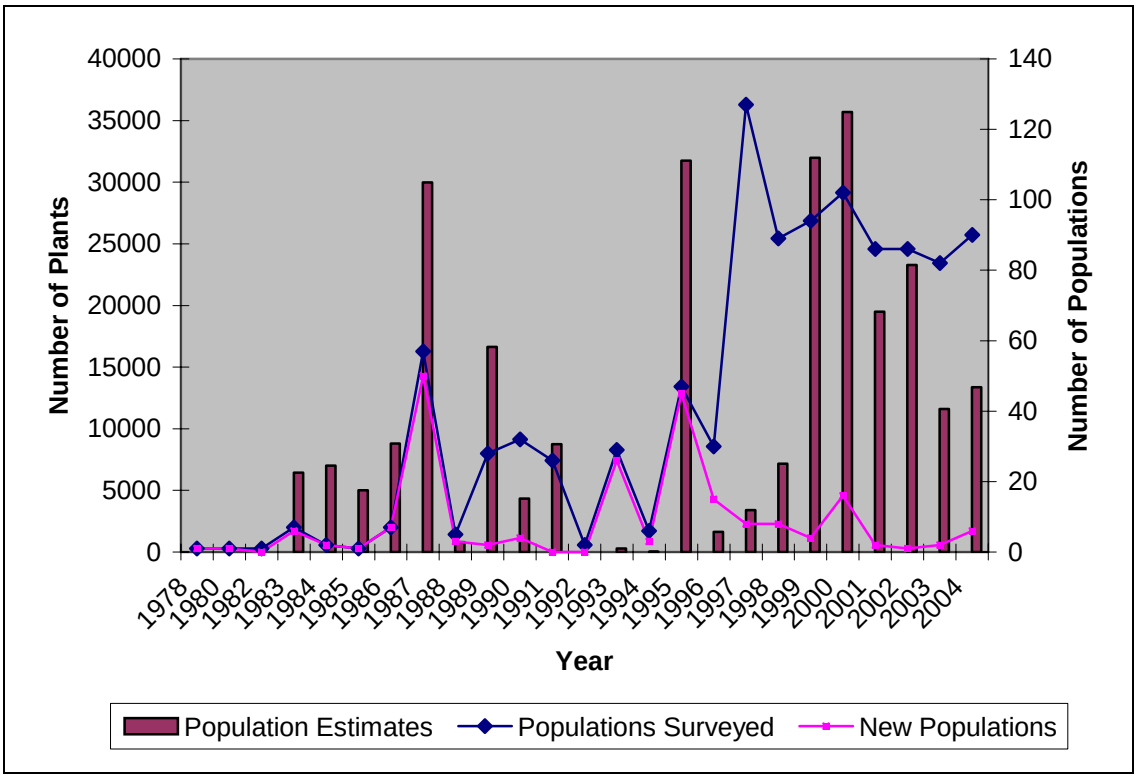

Figure 9. Relationship between number of *H. aquatilis* populations observed (sampled) and number of plants estimated each sample year. Not all populations are revisited each year and many sampled populations do not have an associated quantitative measure of abundance. Also included is the number of new populations found in that given year.

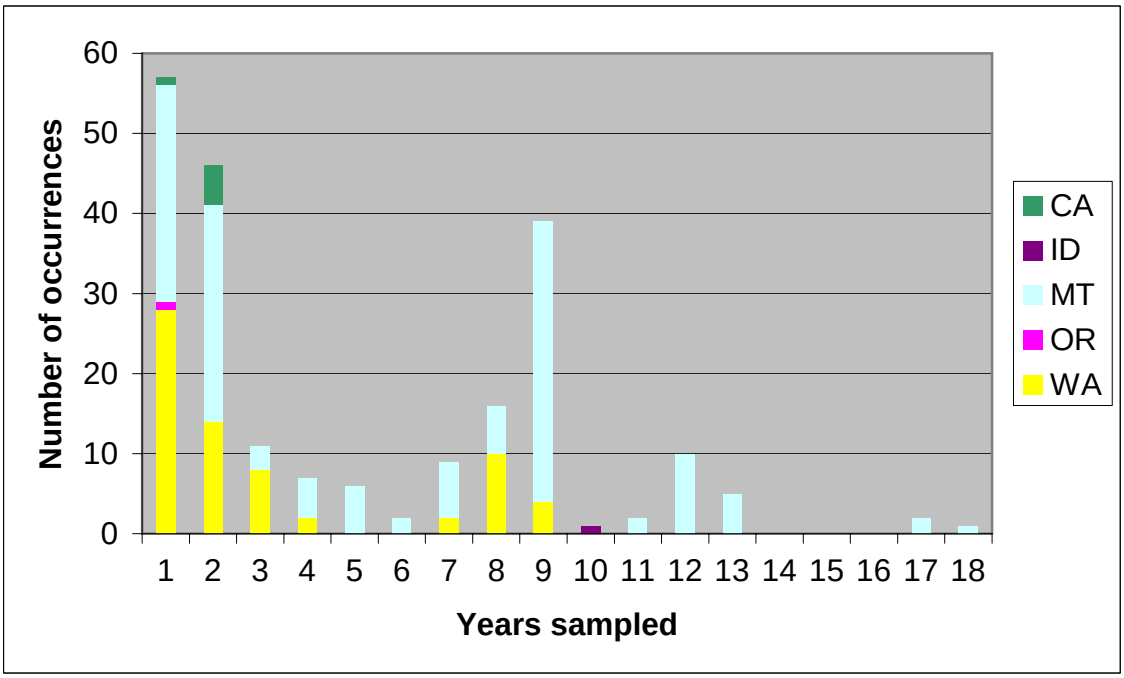

Figure 10. Sampling intensity of individual *H. aquatilis* occurrences stratified by state and number of years sampled.

A semi-quantitative assessment was conducted using the approaches outlined by Regan, Master and Hammerson (2004) and adapted by the Montana Natural Heritage Program for use in ranking animal species of concern (MTNHP 2004). Both of these similar assessment methods assign points to factors such as number of occurrences, population size, area or range extent, trends and threats. Some factors may not be used if data are missing or an estimate of the parameter is too uncertain. The points from the most pertinent criteria are added together to form a final score for the species. Lastly, a Heritage rank of 1 to 5 at a Global and/or State level is assigned based on the final score. The ranking criteria and scores assigned for the *H. aquatilis* Global assessment are found in Table 4 using the two slightly different scoring methods.

Table 4. Ranking factors and assigned scores for the *H. aquatilis* global status assessment. The first point allocation numbers are those used in the scoring method of Regan, Master and Hammerson (2004) and the second point scores are those used in the method outlined by the MTNHP State rank criteria for animal species of concern. See Regan, Master and Hammerson (2004) and MTNHP (2004) for a complete discussion of the methodologies.

Factor	Parameter Estimate	Category	Point Allocation
# of Occurrences	81-300	D	4/Not used
Condition of Occurrences	Many (41-125) with good or excellent viability	E	0/Not used
Population Size	10,000-100,000 plants	F	0/0
Area of Occupancy	0.4-4 km2 (100-1,000 acres)	B	Not used/Not Used
Geographic Range	1,000-5,000 km2? (400-2,000 sq. miles)	D	Not used/-0.25
Long-term Trend	Relatively stable (+- 25% change)	E	0
Short-term Trend	Stable	E	0
Threats-Severity	Moderate	B	-0.75/-0.75
Threats-Scope	Moderate to high		
Threats-Immediacy	Moderate to high		
Intrinsic Vulnerability	Highly vulnerable	A	Not used/Not used
Environmental Specificity	Very narrow with key requirements scarce	A	Not used/Not used
		Initial Point Allocation	0/3.5
		Score	3.25/2.5
		Rank	G3/G2

The assignment of the threat attributes of severity, scope and immediacy is still a mostly subjective process and as such is open to interpretation and discussion. The most apparent threats to the viability of the species appear to be from the high degree of environmental specificity, competition, loss of habitat due to weed invasion and from the species' own biology and large yearly fluctuations in population size due to dependence on favorable environmental conditions in the current and previous years.

B. Status Recommendations

1. NatureServe: The NatureServe Global Rank for water howellia was changed from a "G2" to a "G3" in February 2004 (NatureServe 2005). Results of this range-wide status assessment generally support the "G3" rank, though the species is still close to a "G2" rank due to the small amount of occupied habitat, the clustering of most populations in three main population centers and the threat posed by invasive species.

2. Federal Status: The Draft Recovery Plan for *Howellia aquatilis* (USFWS 1996) listed three primary criteria that must be met for delisting to occur.

It states that, "Delisting will be considered when all the following conditions have been met:

1. Management practices, in accordance with habitat management plans, have reduced and/or controlled anthropogenic threats, thereby maintaining the species and its habitat integrity throughout the currently known range on public lands in five geographic areas for ten years after the effective date of the recovery plan. Monitoring will demonstrate effectiveness of management plans. Management plans will be in place for, at minimum, the following occurrences:

a. 67 occurrences in the Montana geographic area.
b. 33 occurrences in the Spokane County, WA geographic area.
c. 5 occurrences in the Pierce County, WA, geographic area.
d. 4 occurrences in the Clark County, WA, geographic area.
e. 5 occurrences in the Mendocino County, CA, geographic area.

2. Conservation of occurrences on lands not addressed in agency management plans, including those that are within metapopulations as well as outlying geographic extensions, is fostered. Confirm the long-term conservation measures are in place for the occurrence in Latah County, Idaho.

3. A post-listing strategy for monitoring the species population dynamics is in place."

Established monitoring programs on the Flathead National Forest, Montana and on Fort Lewis/McChord Air Force Base in Pierce County, Washington have made great progress in meeting the objectives listed in 1a and 1c. Seven years of monitoring data are now available for 68 ponds from the Flathead National Forest's current monitoring strategy and on Fort Lewis, Washington for 15 ponds from monitoring conducted by the Land Condition Trend Analysis Program. In addition, annual monitoring of the Idaho population has been in place since 1999. Monitoring programs are not known to have been implemented in other areas of the species' range.

Two populations are afforded protection by conservation organizations. The Swan River Oxbow population as part of a Nature Conservancy Preserve and the Idaho population is included in land willed to the Audubon Society. Other significant populations on private lands should be protected as part of the long-term conservation of the species.

Updating and finalizing a recovering strategy should be a primary step in the move towards potential delisting. Establishing criteria or conditions for delisting is not the primary purpose of this assessment. However, several recommended conditions for potential delisting are provided below:

1. Continuation of monitoring programs on the Flathead National Forest, Montana, Fort Lewis/McChord Air Force Base in Pierce County, Washington and in Latah County, Idaho so that a minimum of ten years worth of data are available for those areas.

2. Annual monitoring of populations in Mendocino County, California, the Latah County, Idaho and Benton County, Oregon occurrences, the occurrence on the Swan River Oxbow Preserve in Montana, and all

occurrences on public lands in Washington so that a minimum of 5 years of recent data are available for those populations. Additionally, occurrences on private lands in Spokane County, Washington and the Swan Valley, Montana should be monitored to the extent feasible.

Similar monitoring methods to those employed by the Flathead National Forest, Montana and the Land Condition Trend Analysis Program on Fort Lewis, Washington appear to provide a sound methodology for collecting quantitative survey data in a challenging setting with the requirement of limiting damage to the species. These programs divide the sample ponds in thirds and quarters respectively and estimate the number of plants using one of four abundance classes in each section. A measure of the abundance of *Phalaris arundinacea* and other weedy species should also be incorporated into all monitoring programs.

3. Management plans in place for all occurrences on federal lands across the range of the species, including control strategies for *P. arundinacea* and other invasive weeds, if needed. Control programs for *P. arundinacea* and *Iris pseudacorus* implemented on Fort Lewis, Washington and in Idaho consist primarily of hand pulling and/or clipping these and other invasive species. Similar control measures should be taken across the range of water howellia where invasive species are encroaching into known water howellia habitat.

4. Implementation of conditions 2 and 3 as outlined in the draft recovery plan and listed above.

If monitoring of populations as described in recommendations 1 and 2 above finds that populations are stable though with large yearly fluctuations and management plans and conservation strategies are in place as recommended above, then delisting may be warranted.

The annual nature of the species in conjunction with its narrow ecological niche makes it vulnerable to long-term unfavorable weather patterns and climate change. In addition, the clustering of populations in just a few geographic areas also makes it more susceptible to regional and local influences. Invasion of the species' habitat by non-native species is also a problem that most likely will continually need to be addressed. However, the majority of known populations occur on public lands providing the opportunity for the implementation of conservation measures and strategies beneficial to the long-term survival of the species. Many additional populations occur on Plum Creek Timber Company lands in the Swan Valley of Montana, which may provide additional opportunities for conservation. With implementation of management plans, continued monitoring and conservation protection of additional populations, delisting should be an achievable goal.

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APPENDIX A. *HOWELLIA AQUATILIS* OCCURRENCE DATA BY STATE AND ELEMENT OCCURRENCE NUMBER

Appendix A. *Howellia aquatilis* occurrence data by state and Element Occurrence number. Size in acres is generally the area mapped and not the necessarily the area occupied by the species, which is generally smaller in any given year. Summary statistics of Minimum, Maximun, Mean and Median population estimates are provided for each occurrence. These figures are derived from the yearly quantitative data available for each occurrence, which may be less than the total number of years visited. Rank follows the NatureServe Element Occurrence rank definitions (Appendix E) and was derived primary from recent estimates of population size.

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
CA	1	--	Mendocino National Forest	Mendocino	3520	--	2	75	200	138	137.5	AC
CA	2	--	Mendocino National Forest	Mendocino	4500	--	1	25	25	25	25	C?
CA	3	--	Mendocino National Forest	Mendocino	3710	2.1	2	25	30	28	27.5	C?
CA	4	--	Mendocino National Forest	Mendocino	4000	--	2	200	2000	1100	1100	A?
CA	5	--	Mendocino National Forest	Mendocino	4240	--	2	10	10	10	10	D?
CA	6	--	Mendocino National Forest	Mendocino	3760	--	2	--	--	--	--	U
ID	1	Harvard-Palouse River	Private (willed to Audubon Soc.)	Latah	2560	0.3	10	30	3000	696	100	A
MT	1	Lindbergh Lake	Flathead National Forest	Missoula	4230	0.5	13	0	500	134	75	B
MT	2	Lindbergh Lake	Flathead NF/Plum Creek Timber Co	Missoula	4175	1.7	3	2500	6500	4500	4500	A?
MT	3	Lindbergh Lake	Flathead NF/Private	Missoula	4150	0.4	2	10	5000	2505	2505	A?
MT	4	Lindbergh Lake	Flathead NF/Private	Missoula	4070	0.9	4	0	30	15	15	D?
MT	5	Swan River Oxbow	The Nature Conservancy	Lake	3100	17.9	11	0	5000	3333	5000	A
MT	6	Condon Creek	Flathead National Forest	Missoula	3740	0.6	12	25	2000	791	450	A
MT	7	Swan River West	Flathead National Forest	Lake	3190	0.6	12	50	3500	725	300	A
MT	8	Lost Creek Bench	Flathead National Forest	Lake	3190	0.5	17	0	2500	526	175	A
MT	9	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3250	1.3	13	0	750	205	150	A
MT	10	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3230	0.3	9	0	250	69	37.5	C
MT	11	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3290	3.4	2	150	150	150	150	B?
MT	12	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3235	0.5	11	0	450	114	42.5	B
MT	13	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3240	0.6	13	0	1200	302	225	A
MT	14	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3245	0.3	12	0	500	163	150	A
MT	15	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3245	0.2	9	0	300	122	150	A
MT	16	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3235	0.4	12	0	1200	310	300	A
MT	17	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3245	1.1	5	0	15	5	0	D
MT	18	Dog Creek	Flathead National Forest	Lake	3660	0.8	9	0	450	241	262.5	A
MT	19	Dog Creek	Flathead National Forest	Lake	3580	1.5	9	0	900	411	325	A
MT	20	Condon Creek	Flathead National Forest	Missoula	3740	0.4	18	0	5000	677	210	A
MT	21	Condon Creek	Flathead National Forest	Missoula	3740	1.7	3	0	50	25	25	C?
MT	22	Condon Creek	Flathead National Forest	Missoula	3750	0.1	12	0	750	161	150	A

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
MT	23	Condon Creek	Flathead National Forest	Missoula	3740	0.4	13	0	450	138	150	A
MT	24	Condon Creek	Flathead National Forest	Missoula	3740	0.3	9	0	150	42	25	B
MT	25	Condon Creek	Flathead National Forest	Missoula	3750	0.7	12	0	325	104	25	B
MT	26	Condon Creek	Flathead National Forest	Missoula	3710	0.4	12	25	1500	445	250	A
MT	27	Condon Creek	Flathead National Forest	Missoula	3690	0.7	17	0	450	225	262.5	A
MT	28	Condon Creek	Plum Creek Timber Company	Missoula	3685	0.3	4	0	225	56	0	B?
MT	29	Condon Creek	Plum Creek Timber Company	Missoula	3690	0.4	7	0	650	203	157.5	AC
MT	30	Condon Creek	Plum Creek Timber Company	Missoula	3740	0.3	5	0	1000	504	507.5	AC
MT	31	Condon Creek	Plum Creek Timber Company	Missoula	3620	0.7	4	0	160	40	0	CD
MT	32	Lindbergh Lake	Flathead NF/Private	Missoula	4165	0.3	5	5	900	352	30	B
MT	33	Lindbergh Lake	Flathead NF/Private	Missoula	4130	2.4	2	50	50	50	50	C?
MT	34	Lindbergh Lake	Flathead NF/Private	Missoula	4145	0.3	2	60	60	60	60	C?
MT	35	Lindbergh Lake	Flathead NF/Private	Missoula	4150	0.2	5	0	600	233	50	B
MT	36	Lindbergh Lake	Flathead NF/Private	Missoula	4190	0.5	2	20	120	70	70	BC
MT	37	Lindbergh Lake	Flathead NF/Plum Creek Timber Co	Missoula	4170	0.7	8	0	375	152	100	B
MT	38	Lindbergh Lake	Flathead NF/Plum Creek Timber Co	Missoula	4130	1.1	2	2	1100	551	551	A?
MT	39	Lindbergh Lake	Flathead NF/Plum Creek Timber Co	Missoula	4190	0.5	2	20	1200	610	610	A?
MT	40	Lindbergh Lake	Flathead NF/Plum Creek Timber Co	Missoula	4225	0.3	2	0	350	175	175	AC
MT	41	Lindbergh Lake	Flathead NF/Private	Missoula	4015	1.0	1	55	55	55	55	C?
MT	42	Lindbergh Lake	Flathead NF/Private	Missoula	3995	1.9	1	55	55	55	55	C?
MT	43	Lindbergh Lake	Flathead National Forest	Missoula	4280	0.2	9	0	150	39	25	B
MT	44	Lindbergh Lake	Flathead National Forest	Missoula	4215	1.1	12	0	340	185	250	A
MT	45	Lindbergh Lake	Flathead National Forest	Missoula	4250	0.8	13	0	500	217	200	A
MT	46	Lindbergh Lake	Flathead National Forest	Missoula	4230	1.8	5	0	50	24	25	C
MT	47	Lindbergh Lake	Flathead National Forest	Missoula	4215	0.7	12	0	350	165	175	A
MT	48	Lindbergh Lake	Flathead National Forest	Missoula	4215	0.4	12	0	250	101	75	B
MT	49	Lindbergh Lake	Flathead NF/Private	Missoula	4150	0.5	6	10	2000	843	625	A
MT	50	Lindbergh Lake	Flathead NF/Private	Missoula	4295	1.3	1	750	750	750	750	A?
MT	51	Lindbergh Lake	Flathead NF/Private	Missoula	4425	0.1	2	20	120	70	70	BC
MT	52	Kraft Creek	Private	Missoula	4010	1.8	2	20	200	110	110	AC
MT	53	Salmon Prairie	Flathead NF/Private	Lake	3450	2.8	2	250	250	250	250	A?
MT	54	Elk Creek	Flathead NF/Plum Creek Timber Co	Missoula	3810	2.8	4	50	900	481	487.5	A
MT	55	Elk Creek	Flathead National Forest	Missoula	3820	1.1	9	25	600	278	200	A
MT	56	Lindbergh Lake	Flathead National Forest	Missoula	4310	0.5	9	0	75	35	27	C

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
MT	57	Lost Creek-Cilly Creek Ponds	Flathead National Forest	Lake	3190	1.2	9	0	25	5	0	D
MT	58	Salmon Prairie	Private	Lake	3555	0.3	1	30	30	30	30	C?
MT	59	Shay Lake Pothole	Plum Creek Timber Company	Lake	3560	0.2	2	0	50	25	25	C?
MT	60	Shay Lake Pothole	Plum Creek Timber Company	Lake	3540	0.6	2	20	50	35	35	C?
MT	61	Shay Lake Pothole	Flathead National Forest	Lake	3580	0.2	9	0	200	91	150	A
MT	62	Shay Lake Pothole	Flathead National Forest	Lake	3580	0.7	9	0	450	142	125	A
MT	63	Stoner Lake Pothole #14	Plum Creek Timber Company	Missoula	3980	0.3	2	0	300	150	150	AC
MT	64	Stoner Lake Pothole #12	Plum Creek Timber/Private	Missoula	3960	0.8	2	100	100	100	100	BC
MT	65	Stoner Lake Pothole #8	Plum Creek Timber Company	Missoula	3960	2.8	2	0	100	50	50	C?
MT	66	Stoner Lake Pothole #6	Flathead NF/Plum Creek Timber Co	Missoula	3940	1.0	2	50	50	50	50	C?
MT	67	Stoner Lake Pothole #18	Plum Creek Timber Company	Missoula	3980	1.7	2	500	500	500	500	A?
MT	68	Stoner Lake Pothole #20	Plum Creek Timber Company	Missoula	4000	0.4	2	50	50	50	50	C?
MT	69	Stoner Lake Pothole #21	Plum Creek Timber Company	Missoula	4020	0.8	2	0	200	100	100	AC
MT	70	Condon Creek	Flathead NF (Condon Creek Botanical Area)	Missoula	3760	0.3	9	0	300	109	112.5	A
MT	71	Holland Lake	Flathead National Forest	Missoula	4160	0.2	9	10	300	123	150	A
MT	72	Owl Creek	Flathead National Forest	Missoula	4320	0.3	9	75	3000	591	300	A
MT	73	Holland Lake Pond #2	Flathead National Forest	Missoula	4160	0.5	9	0	300	155	100	A
MT	74	Holland Lake Pond #3	Flathead National Forest	Missoula	4160	0.3	9	25	150	81	50	B
MT	75	Holland Lake Pond #4	Flathead National Forest	Missoula	4160	0.1	9	0	200	111	150	B
MT	76	Holland Lake Pond #5	Flathead National Forest	Missoula	4080	1.8	9	25	550	300	362.5	A
MT	77	Barber Creek	Flathead NF/Plum Creek Timber Co	Missoula	4260	0.2	2	20	5000	2510	2510	A?
MT	78	Barber Creek	Flathead National Forest	Missoula	4260	0.2	9	0	350	113	75	B
MT	79	Holland Creek	Flathead National Forest	Missoula	3960	0.4	9	0	1000	166	25	B
MT	80	Barber Creek Gravel Pit South Pond #2	Flathead National Forest	Missoula	3960	0.7	9	0	1000	133	25	B
MT	81	Holland Creek	Flathead National Forest	Missoula	4080	0.9	9	20	450	233	300	A
MT	82	Holland Lake Pond #6	Flathead NF/Private	Missoula	4100	3.6	2	20	200	110	110	AC
MT	83	Holland Lake Pond #7	Flathead NF/Private	Missoula	4100	0.3	4	0	200	88	75	B
MT	84	Beaver Creek/Lindberg Lake Road (East Pond)	Flathead National Forest	Missoula	4020	0.3	9	0	750	145	75	B
MT	85	Windfall Creek	Private	Missoula	3960	1.4	2	--	--	--	--	U
MT	86	Elk Creek Pond 1-1	Flathead National Forest	Missoula	4020	0.5	9	20	1000	302	300	A
MT	87	Elk Creek Pond 1-2	Flathead National Forest	Missoula	4020	0.2	9	25	1000	219	150	A
MT	88	Elk Creek Pond 1-3	Flathead NF/Plum Creek Timber Co	Missoula	3960	1.2	2	0	1000	500	500	A?
MT	89	Elk Creek Pond 1-4	Flathead NF/Plum Creek Timber Co	Missoula	4000	0.6	2	100	1000	550	550	A?

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
MT	90	Piper Creek Pond #1	Flathead National Forest	Lake	3480	0.1	9	0	3000	414	150	A
MT	91	Piper Creek Pond #2	Flathead National Forest	Lake	3520	0.4	9	0	2000	347	150	A
MT	92	Piper Creek Pond #3	Flathead National Forest	Lake	3420	0.2	8	0	200	63	25	B
MT	93	Piper Creek Pond #4	Flathead National Forest	Lake	3320	0.2	8	0	1000	191	75	B?
MT	94	Piper Creek Pond #5	Flathead National Forest	Lake	3520	0.6	9	0	300	175	200	A
MT	95	Piper Creek Pond #6	Flathead National Forest	Lake	3540	0.4	9	0	200	56	25	BC
MT	96	Piper Creek Pond #7	Flathead National Forest	Lake	3540	0.5	9	0	300	97	24	B
MT	97	Piper Creek Pond #8	Flathead National Forest	Lake	3540	0.2	9	0	75	28	25	B
MT	98	Piper Creek Pond #9	Flathead National Forest	Lake	3540	0.0	9	25	300	128	150	A
MT	99	Piper Creek Pond #10	Flathead National Forest	Lake	3520	0.3	9	0	1000	238	150	A
MT	100	Piper Creek Pond #11	Flathead National Forest	Lake	3580	0.2	9	0	2000	353	150	A
MT	101	Piper Creek Pond #2	Flathead National Forest	Lake	3600	0.3	9	0	3000	478	150	A
MT	102	Condon Creek	Flathead National Forest	Missoula	3720	0.9	8	10	225	86	50	B
MT	103	Condon Creek	Flathead National Forest	Missoula	3720	0.3	8	0	50	13	0	D
MT	104	Cilly Creek	Flathead National Forest	Lake	3240	0.6	8	50	450	313	400	A
MT	105	Dog Creek	Flathead National Forest	Lake	3700	2.6	1	50	50	50	50	C?
MT	106	Holland Lake	Flathead National Forest	Missoula	4000	0.4	7	0	150	89	150	A
MT	107	Pierce Creek	Flathead National Forest	Missoula	4100	0.2	7	0	150	79	50	B
MT	108	U-024 pond in Cilly Creek Cluster	Flathead National Forest	Lake	3230	2.0	7	0	650	343	400	A
MT	109	Pond U-084	Flathead National Forest	Missoula	4000	0.9	7	0	150	100	150	B
MT	110	Pond north of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	4180	0.5	3	0	25	9	2	D
MT	111	Pond U-53	Flathead National Forest	Missoula	4020	0.3	7	0	75	36	25	B
MT	112	Pond U-052	Flathead National Forest	Missoula	3799	0.3	7	0	450	221	275	A
MT	113	Pond U-073	Flathead National Forest	Lake	3540	0.2	6	0	150	58	50	C
MT	114	Was Pond U-32	Flathead NF/Plum Creek Timber Co	Missoula	4180	0.8	2	200	200	200	200	B?
MT	115	Whitetail Creek	Plum Creek Timber/MT DNRC	Lake	3180	0.9	1	1500	1500	1500	1500	A?
MT	116	Porcupine Creek	Flathead NF/MT DNRC	Lake	3200	0.3	1	1000	1000	1000	1000	A?
MT	117	Porcupine Creek	MT State DNRC	Lake	3200	0.5	1	550	550	550	550	A?
MT	118	North of Cygnet Lake	Flathead National Forest	Missoula	4250	0.5	1	10	10	10	10	D?
MT	119	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	3990	0.7	1	--	--	--	--	U
MT	120	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	3990	0.3	1	--	--	--	--	U
MT	121	North of Cygnet Lake	Flathead NF/Private	Missoula	4040	1.3	1	--	--	--	--	U
MT	122	North Side of Cygnet Lake	Plum Creek Timber Company	Missoula	4010	1.0	1	14	14	14	14	D?

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
MT	123	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	4180	0.5	1	--	--	--	--	U
MT	124	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	4160	0.3	1	--	--	--	--	U
MT	125	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	4160	0.5	1	2000	2000	2000	2000	A?
MT	126	North of Cygnet Lake	Flathead NF/Plum Creek Timber Co	Missoula	4180	0.4	1	13	13	13	13	D?
MT	127	North of Cygnet Lake	Flathead National Forest	Missoula	4000	0.9	1	--	--	--	--	U
MT	128	North of Cygnet Lake	Flathead National Forest	Missoula	4000	1.8	1	--	--	--	--	U
MT	129	North of Cygnet Lake	Flathead National Forest	Missoula	4040	0.8	1	--	--	--	--	U
MT	130	Road 10161 Pond (Transplant Pond A)	Flathead National Forest	Lake	3136	0.5	5	0	32	12	4	D
MT	131	Beaver Creek	Flathead National Forest	Missoula	4232	0.6	2	0	25	13	12.5	D?
MT	135	Falls Creek	Flathead NF/Plum Creek Timber Co	Missoula	3690	0.5	1	50	50	50	50	C?
MT	136	Glacier Creek	Flathead National Forest	Missoula	4225	0.2	1	75	75	75	75	C?
MT	137	Glacier Creek	Flathead National Forest	Missoula	4360	0.2	1	250	250	250	250	A?
MT	138	Glacier Creek	Flathead National Forest	Missoula	4331	0.7	1	5	5	5	5	D?
MT	139	Glacier Creek	Flathead National Forest	Missoula	4429	0.8	1	3	3	3	3	D?
MT	140	Condon Creek	Flathead National Forest	Lake	3500	0.5	1	10	10	10	10	D?
MT	141	Swan River State Forest	MT State DNRC	Lake	3218	0.6	1	300	300	300	300	A?
OR	8	--	Finley National Wildlife Refuge	Benton	--	--	1	--	--	--	--	U
WA	1	Dishman Hills Ponds	Dishman Hills NRCA (State and County?)	Spokane	--	0.5	2	--	--	--	--	U
WA	2	Blackwater Islands RNA	Ridgefield National Wildlife Refuge	Clark	10	--	2	--	--	--	--	U
WA	3	Curtis Road 1	Private	Spokane	2300	1.0	1	500	500	500	500	A?
WA	4	Curtis Road 2	Private	Spokane	2320	0.5	1	500	500	500	500	A?
WA	5	Bretz Pothole	Private	Spokane	2280	--	2	500	500	500	500	A?
WA	6	Cameron Road	Private	Spokane	--	1.0	1	--	--	--	--	U
WA	7	Jennings Road	Private	Spokane	2320	2.0	1	--	--	--	--	U
WA	8	Cross Tracks 1	Private	Spokane	--	0.2	1	--	--	--	--	U
WA	9	Cross Tracks 2	Private	Spokane	--	0.5	1	--	--	--	--	U
WA	10	Cross Tracks 3	Private	Spokane	--	--	1	--	--	--	--	U
WA	11	East Findley lake	Turnbull National Wildlife Refuge	Spokane	2300	4.0	4	0	402	137	10	B
WA	12	Across from Kepple	Private	Spokane	2320	2.0	1	--	--	--	--	U
WA	13	East Campbell Lake	Turnbull National Wildlife Refuge	Spokane	2320	1.0	2	--	--	--	--	U
WA	14	Squirrel View	Turnbull National Wildlife Refuge	Spokane	2290	2.0	2	--	--	--	--	U
WA	15	Lily Pond	Private	Spokane	2300	0.25	1	--	--	--	--	U
WA	16	Anderson Road	Private	Spokane	--	1.0	1	--	--	--	--	U

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
WA	17	North of West Tritt Lake	Turnbull National Wildlife Refuge	Spokane	2300	1.0	1	--	--	--	--	U
WA	18	Pine Creek RNA South	Turnbull National Wildlife Refuge	Spokane	2300	1.0	4	0	156	53	2	BC
WA	19	North Fee Station	Turnbull National Wildlife Refuge	Spokane	2250	1.0	2	--	--	--	--	D?
WA	20	Turnbull Pond 85	Turnbull National Wildlife Refuge	Spokane	2300	--	3	0	57	20	3	C
WA	21	Turnbull Pond 21A	Turnbull National Wildlife Refuge	Spokane	2300	--	3	0	1	1	0.5	D?
WA	22	Turnbull Pond 77	Turnbull National Wildlife Refuge	Spokane	2300	--	2	--	--	--	--	D?
WA	23	Turnbull Pond 72	Turnbull National Wildlife Refuge	Spokane	2300	--	1	2	2	2	2	D?
WA	24	Turnbull Pond 55	Turnbull National Wildlife Refuge	Spokane	2300	--	2	2	150	76	76	C?
WA	25	Turnbull Pond 39	Turnbull National Wildlife Refuge	Spokane	2300	--	1	3	3	3	3	D?
WA	26	Turnbull Pond 21C	Turnbull National Wildlife Refuge	Spokane	2300	--	1	0	0	--	--!	U
WA	28	Turnbull Pond 61	Turnbull National Wildlife Refuge	Spokane	2300	--	3	46	75	61	60.5	C
WA	29	Turnbull Pond 1B	Turnbull National Wildlife Refuge	Spokane	2300	--	1	1	1	1	1	D?
WA	30	Tunbull Pond 21B	Turnbull National Wildlife Refuge	Spokane	2300	--	1	5	5	5	5	D?
WA	31	Turnbull Pond 31	Turnbull National Wildlife Refuge	Spokane	2300	--	2	0	3	2	1.5	D?
WA	32	Turnbull Pond 29	Turnbull National Wildlife Refuge	Spokane	2280	1.0	3	2	75	32	18	C
WA	33	Turnbull Pond 12	Turnbull National Wildlife Refuge	Spokane	2300	--	2	--	--	--	--	D?
WA	34	Tunbull Pond 1A	Turnbull National Wildlife Refuge	Spokane	2330	--	1	1	1	1	1	D?
WA	35	Turnbull Pond 112	Turnbull National Wildlife Refuge	Spokane	2300	--	1	3	3	3	3	D?
WA	36	Turnbull Pond 96	Turnbull National Wildlife Refuge	Spokane	2300	--	3	0	15	8	7.5	D?
WA	37	Hog Lake NW	Bureau of Land Management	Spokane	2180	5.0	1	50	50	50	50	C?
WA	38	Turnbull Pond 107	Turnbull National Wildlife Refuge	Spokane	2300	--	2	2	30	16	16	D?
WA	39	Foot Wetland	Fort Lewis	Pierce	320	20.0	8	20	655	379	331.5	A
WA	40	South Bentsen	Fort Lewis	Pierce	340	--	8	0	100	17	0	C
WA	41	Bentsen Wetland	Fort Lewis/McCord Air Force Base	Pierce	320	1.0	8	0	8200	1847	729	A
WA	42	Binocular Pond	Fort Lewis	Pierce	320	--	9	6	90	42	27.5	B
WA	43	Shaver Kettle	Fort Lewis	Pierce	330	0.2	8	120	3750	1178	800	A
WA	44	Trench Wetland	Fort Lewis	Pierce	330	0.5	8	20	300	177	205	A
WA	45	NE Chamber Satellite	Fort Lewis	Pierce	315	0.2	8	0	72	26	11.5	C
WA	46	North Chambers	Fort Lewis	Pierce	315	5.0	9	325	2240	768	470	A
WA	47	West Shaver Pond	Fort Lewis	Pierce	315	2.5	9	375	822	667	785	A
WA	48	Crone Marsh	Fort Lewis	Pierce	340	40.0	9	920	12275	4182	2427.5	A
WA	49	Joseph Marsh	Fort Lewis	Pierce	350	10.0	7	42	1127	445	300	A
WA	50	Middle East Chambers	Fort Lewis	Pierce	320	0.5	8	6	104	35	18.5	B
WA	51	Dailman Lake	Fort Lewis	Pierce	320	40.0	8	39	565	300	312	A

State	EO#	Name	Ownership	County	Elevation (ft)	Size (ac)	Years visited	Min	Max	Mean	Median	Rank
WA	52	Hamilton Lake	Fort Lewis	Pierce	320	8.0	8	0	30	16	13	C
WA	53	Chambers East	Fort Lewis	Pierce	320	1.0	8	22	1038	286	113.5	A
WA	54	Turnbull Pond 13	Turnbull National Wildlife Refuge	Spokane	2300	--	1	9	9	9	9	D?
WA	55	Turnbull Pond 82	Turnbull National Wildlife Refuge	Spokane	2300	--	1	1	1	1	1	D?
WA	56	Turnbull Pond 63	Turnbull National Wildlife Refuge	Spokane	2300	--	2	0	3	2	1.5	D?
WA	57	Turnbull Pond 32	Turnbull National Wildlife Refuge	Spokane	2300	--	3	0	39	13	1	D
WA	58	Turnbull Pond 138	Turnbull National Wildlife Refuge	Spokane	2300	--	3	15	100	71	98	B
WA	59	Turnbull Pond 139	Turnbull National Wildlife Refuge	Spokane	2300	--	2	1	9	5	5	D?
WA	60	Turnbull Pond 117	Turnbull National Wildlife Refuge	Spokane	2300	--	1	3	3	3	3	D?
WA	61	Turnbull Pond 18	Turnbull National Wildlife Refuge	Spokane	2300	--	3	1	10	5	3	D
WA	62	Turnbull Pond 149	Turnbull National Wildlife Refuge	Spokane	2300	--	2	0	111	56	55.5	BD
WA	63	Turnbull Pond 150	Turnbull National Wildlife Refuge	Spokane	2300	--	1	76	76	76	76	C?
WA	64	Powder Factory	Private	Thurston	220	--	1	--	--	--	--	U
WA	65	Campbell Lake NW	Private	Spokane	2340	--	1	7	7	7	7	D?
WA	66	Willow Kettle, 13th Division Prairie	Fort Lewis	Pierce	390	--	7	100	429	238	200	A
WA	67	Smythe Road North	WA State DNR	Spokane	2380	--	1	1500	1500	1500	1500	A?
WA	68	Burnett Road	WA State DNR	Spokane	2400	6.5	1	1500	1500	1500	1500	A?
WA	--	Training area 11	Fort Lewis	Pierce	--	--	1	--	--	--	--	U

APPENDIX B. ANNUAL *HOWELLIA AQUATILIS* SURVEY DATA BY STATE AND ELEMENT OCCURRENCE NUMBER

Appendix B. Annual *Howellia aquatilis* population estimates/counts by state and Element Occurrence number. Only includes occurrences presumed to be extant. Data are compiled from individual state Natural Heritage Programs, the Flathead National Forest's annual monitoring data and the Land Trend Analysis Program at Fort Lewis, WA. Numerical values for Montana populations surveyed as part of the Flathead National Forest's monitoring plan are derived from estimates of individuals in sampling quadrats. Quadrats are assigned a value of 0 = no plants found, Low = 1 to 50 plants, Moderate = 50-100 plants or High = >100 plants. Final quantitative estimates for this assessment were derived by assigning numerical values of 25, 75 and 150 for Low, Medium and High respectively and adding those numbers together to come up with a final population estimate for that year. In some cases, the midpoint of an estimated population range is provided.

"-1" = Site visit in which no quantitative survey data exists or was not available for this assessment. However, water howellia was observed during a visit that year and a qualitative measure of abundance might exist.
"0" = Site visit in which no water howellia was observed that year.

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CA	1																		75	200							
CA	2																		25								
CA	3																		25					30			
CA	4																		200	2000							
CA	5																		10				10				
CA	6																				-1	-1					
ID	1	-1									30							50	100			300	-1	3000	-1	-1	-1
MT	1						500			85		350	27	25						2	50	0	100	300	75	25	200
MT	2						6500			2500										-1							
MT	3					5000														10							
MT	4		-1		-1	30														0							
MT	5							5000		5000	-1	-1	-1	-1	-1	-1	-1	-1		0							
MT	6								2000	2000		1500	750	900						-1	25	50	450		450	225	350
MT	7									3500		1500	550	1500						50	50	300	300	300	300	50	300
MT	8									2500	-1	1200	40	1500	-1		0	-1	-1	-1	50	300	300	300	50	50	25
MT	9									550	-1	750	220	40						-1	0	150	175	75	225	0	75
MT	10									250										-1	0	75	150	25	50	0	0
MT	11									150										-1							
MT	12									450		16	35	260						-1	25		225	50	0	0	75
MT	13									1200	-1	600	33	310						-1	25	300	225	300	175	0	150
MT	14									350		500	200	90						-1	0	150	150	150	50	0	150
MT	15									300										50	0	150	150	150	150	0	150
MT	16									400		1200	400	70						50	0	300	300	300	300	100	300

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MT	17									11		15	0	0						0							
MT	18									200										-1	25	25	450	450	450	0	325
MT	19									175										0	25	0	825	750	900	325	700
MT	20								5000	1000	-1	1250	190	210	-1		0	-1	-1	-1	50	175	300	225	50	50	300
MT	21								-1	50										0							
MT	22									200		750	80	100						0	25	25	150	150	150	150	150
MT	23								300	3		450	20	110						-1	0	25	150	150	150	150	150
MT	24									30										0	25	25	25	75	25	25	150
MT	25									25		110	0	15						0	0	0	225	325	200	25	325
MT	26									250		700	1200	1500						-1	25	300	300	175	200	50	200
MT	27									300	-1	350	200	195	-1		0	-1	-1	-1	0	25	225	325	300	325	450
MT	28									225										0	0	0					
MT	29									250		650	150	165						-1	0	0					
MT	30									1000		1000	0	15						-1							
MT	31									160										0	0	0					
MT	32					800						900	5	25						30							
MT	33					50														-1							
MT	34					60														-1							
MT	35					500						600	0	15						50							
MT	36									120										20							
MT	37									12										-1	100	50	375	300	225		0
MT	38									1100										2							
MT	39									1200										20							
MT	40									350										0							
MT	41									55																	
MT	42									55																	
MT	43									22										0	0	25	75	25	50	0	150
MT	44									340		105	0	0						3	25	300	300	325	200	300	325
MT	45									300		350	10	500			10			50	75	200	250	450	175	0	450
MT	46									50		40	3	25						0							
MT	47									200		250	150	200						0	25	50	100	250	350	50	350
MT	48									250		200	0	20						20	50	50	175	100	150	25	175
MT	49									1750		2000	250	1000			10			50							
MT	50									750																	

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MT	51									120										20							
MT	52									200										20							
MT	53										250									-1							
MT	54										450									50	525	900					
MT	55										100									-1	25	250	150	450	600	50	600
MT	56											27								10	0	0	75	75	50	25	50
MT	57											22								0	0	0	0	0	0	25	0
MT	58												30														
MT	59																	50		0							
MT	60																	50		20							
MT	61																	200		20	0	0	150	150	150	0	150
MT	62																	100		0	0	250	125	150	200	0	450
MT	63																	300		0							
MT	64																	100		-1							
MT	65																	100		0							
MT	66																	50		-1							
MT	67																	500		-1							
MT	68																	50		50							
MT	69																	200		0							
MT	70																	300		-1	0	25	150	75	150	25	150
MT	71																	300		10	25	150	150	150	150	150	25
MT	72																	3000		-1	150	300	300	300	75	300	300
MT	73																	100		20	0	25	300	300	300	300	50
MT	74																	50		-1	25	25	150	150	50	150	50
MT	75																	200		20	25	150	150	150	150	0	150
MT	76																	300		-1	25	50	475	450	425	125	550
MT	77																	5000		20							
MT	78																	350		-1	0	75	75	75	150	25	150
MT	79																	1000		-1	0	75	25	25	25	25	150
MT	80																	1000		0	0	25	25	50	25	50	25
MT	81																	200		20	25	300	300	325	300	450	175
MT	82																	200		20							
MT	83																	200		0	0	150					
MT	84																	750		1	75	150	150	75	50	0	50

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MT	85																	-1		-1							
MT	86																	1000		20	100	300	225	175	300	300	300
MT	87																	1000		50	25	150	150	150	150	150	150
MT	88																	1000		0							
MT	89																	1000		100							
MT	90																	3000		0	25	75	150	150	150	25	150
MT	91																	2000		-1	25	150	150	150	150	0	150
MT	92																	200		0	25	25	75	150	25		0
MT	93																	1000		50	25	75	75	150	150		0
MT	94																	300		0	0	300	300	150	300	25	200
MT	95																	200		0	25	25	75	0	0	25	150
MT	96																	24		0	0	0	150	100	300	0	300
MT	97																	24		0	0	25	25	75	50	0	50
MT	98																	300		-1	25	150	75	150	150	25	150
MT	99																	1000		-1	150	150	150	150	150	0	150
MT	100																	2000		-1	75	150	150	150	150	0	150
MT	101																	3000		-1	75	150	150	150	150	0	150
MT	102																			10	25	25	50	50	100	200	225
MT	103																			50	0	0	0	0	0	50	0
MT	104																			100	50	450	450	450	450	200	350
MT	105																			50							
MT	106																				25	0	0	150	150	150	150
MT	107																				25	150	150	25	150	0	50
MT	108																				0	525	650	375	425	25	400
MT	109																				0	25	150	150	75	150	150
MT	110																						2		25		0
MT	111																				0	50	75	75	25	0	25
MT	112																				0	275	450	75	350	0	400
MT	113																				0	75	25	75		25	150
MT	114																					200	-1				
MT	115																						1500				
MT	116																						1000				
MT	117																						550				
MT	118																						10				

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MT	119																						-1				
MT	120																						-1				
MT	121																						-1				
MT	122																						14				
MT	123																						-1				
MT	124																						-1				
MT	125																						2000				
MT	126																						13				
MT	127																						-1				
MT	128																						-1				
MT	129																						-1				
MT	130												32	4	2						0	0		4			
MT	131																					0		25			
MT	135																										50
MT	136																										75
MT	137																										250
MT	138																										5
MT	139																										3
MT	140																									10	
MT	141																									300	
OR	8																								-1		
WA	1					-1																			-1		
WA	2			-1											-1												
WA	3								500																		
WA	4								500																		
WA	5								500				-1														
WA	6									-1																	
WA	7									-1																	
WA	8									-1																	
WA	9									-1																	
WA	10									-1																	
WA	11									-1						10			402	0							
WA	12									-1																	
WA	13									-1			-1														

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
WA	14									-1									-1								
WA	15									-1																	
WA	16									-1																	
WA	17												-1														
WA	18												-1			2			156	0							
WA	19												-1							0							
WA	20															3			57	0							
WA	21															-1			1	0							
WA	22															-1				0							
WA	23															2											
WA	24															2			150								
WA	25															3											
WA	26															-1											
WA	28															-1			46	75							
WA	29															1											
WA	30															5											
WA	31															3				0							
WA	32															75			18	2							
WA	33															-1				0							
WA	34															1											
WA	35															3											
WA	36															-1			15	0							
WA	37															50											
WA	38															2			30								
WA	39																-1				338	655	295	20	325	642	-1
WA	40																-1				4	100	0	0	0	0	-1
WA	41																-1				0	1088	8200	370	300	1125	-1
WA	42																		-1	-1	90	85	26	29	18	6	-1
WA	43																		-1		800	120	1200	800	3750	400	-1
WA	44																		-1		20	30	150	260	300	300	-1
WA	45																		-1		0	72	20	1	3	61	-1
WA	46																		-1	-1	706	2240	535	325	405	395	-1
WA	47																		-1	-1	804	430	822	375	770	800	-1
WA	48																	-1		-1	1500	12275	5860	1184	3355	920	-1

State	EO#	1967	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
WA	49																		-1			500	42	300	1127	255	-1
WA	50																		-1		53	104	25	10	12	6	-1
WA	51																			-1	39	374	85	250	487	565	-1
WA	52																			4	13	11	0	25	30	30	-1
WA	53																			-1	91	1038	136	22	27	402	-1
WA	54															9											
WA	55															1											
WA	56															3				0							
WA	57															1			39	0							
WA	58															100			98	15							
WA	59															1			9								
WA	60															3											
WA	61															3			10	1							
WA	62																		111	0							
WA	63																		76								
WA	64																	-1									
WA	65																			7							
WA	66																				429	100	100	200	200	400	-1
WA	67																					1500					
WA	68																					1500					
WA	Training area 11																										-1

APPENDIX C. *HOWELLIA AQUATILIS* BIBLIOGRAPHY

HOWELLIA AQUATILIS BIBLIOGRAPHY

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APPENDIX D. GLOBAL/STATE RANK DEFINITIONS

HERITAGE PROGRAM RANKS

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

GLOBAL RANK DEFINITIONS (NatureServe 2003)

G1	Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction
G2	Imperiled because of rarity and/or other factors making it vulnerable to extinction
G3	Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations
G4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery
G5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery
T1-5	**Infraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank

STATE RANK DEFINITIONS

S1	At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state
S2	At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state
S3	Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas
S4	Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern
S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

COMBINATION RANKS

G#G# or S#S#	**Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

QUALIFIERS

NR	Not ranked
Q	**Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

X	**Presumed Extinct**—Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	**Possibly Extinct**—Species known from only historical occurrences, but may never-theless still be extant; further searching needed
U	**Unrankable**—Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	**Hybrid**—Entity not ranked because it represents an interspecific hybrid and not a species
?	**Inexact Numeric Rank**—Denotes inexact numeric rank
C	**Captive or Cultivated Only**—Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	**Accidental**—Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	**Zero Occurrences**—Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	**Potential**—Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	**Reported**—Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	**Synonym**—Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	**Breeding**—Rank refers to the breeding population of the species in Montana
N	**Nonbreeding**—Rank refers to the non-breeding population of the species in Montana

APPENDIX E. ELEMENT OCCURRENCE RANK DEFINITIONS

ELEMENT OCCURRENCE RANK DEFINITIONS

A - Excellent estimated viability/ecological integrity
A? - Possibly excellent estimated viability/ecological integrity
AB - Excellent or good estimated viability/ecological integrity
AC - Excellent, good, or fair estimated viability/ecological integrity
B - Good estimated viability/ecological integrity
B? - Possibly good estimated viability/ecological integrity
BC - Good or fair estimated viability/ecological integrity
BD - Good, fair, or poor estimated viability/ecological integrity
C - Fair estimated viability/ecological integrity
C? - Possibly fair estimated viability/ecological integrity
CD - Fair or poor estimated viability/ecological integrity
D - Poor estimated viability/ecological integrity
D? - Possibly poor estimated viability/ecological integrity
E - Verified extant (viability/ecological integrity not assessed)
F - Failed to find
F? - Possibly failed to find
H - Historical
H? - Possibly historical
X - Extirpated
X? - Possibly extirpated
U - Unrankable
NR - Not ranked